The Effect of Multimedia Technology on Deep Learning of Chinese Characters Among Primary School Students

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Although deep learning is a hot topic in the educational field nowadays, the study of how multimedia technology affects students' deep learning of Chinese characters is still insufficient. Therefore, a quantitative study administered via a quasi-experiment was conducted, aiming to: analyse the difference in literacy writing achievement between students taught using multimedia technology as compared to those taught with conventional method; and explore whether the multimedia technology promotes deep learning of Chinese characters. A total of 73 primary school students were selected using the random sampling method. 36 pre- and post-test questions identified the difference in Chinese literacy writing achievement between the experimental group (n = 37) and control group (n = 36), while a questionnaire assessed differences in deep learning. The findings show that multimedia technology had no significant impact on the cognitive and intrapersonal domains but was effective in the interpersonal domain of deep learning, which suggested teachers to make full use of multimedia technology in cultivating students' communication, collaboration, responsibility, and conflict resolution skills.

Keywords: multimedia technology, deep learning, Chinese literacy achievement, 1st grade primary school student

INTRODUCTION

With the rapid development of the information age, the relationship between technology and education is becoming stronger. In China, educational policies, curriculum reform policies, and the training requirements of Chinese subjects have emphasised the integration of multimedia technology and Chinese teaching in many aspects. Chinese literacy ability plays a fundamental role that cannot be ignored in Chinese and other disciplines and is an extremely important part of basic education. According to the Compulsory Education Chinese Curriculum Standards (2011), literacy is the foundation of reading and writing, the focus of teaching in the lower grades, and an important teaching content throughout the entire stage of compulsory education. Literacy of Chinese characters is the premise and guarantee of cultivating Chinese key competence, making them an important way to cultivate students' intelligence, which will help to improve students' ability to appreciate culture and aesthetics (Jiang, 2010).

The concept of multimedia proposed by Guan et al. (2018) refers to the combination of media types that should include text (alphabetic or numeric), symbols, images, pictures, audio, video, and animations.

Multimedia technology, the kind of information technology used in Chinese literacy teaching, plays an important role in creating situations, providing alternative experiences, game-learning, training and practising, and enriching learning backgrounds (Jiang, 2010). Multimedia technology is beneficial in turning abstract concepts into concrete concepts and presenting large volumes of information within a limited time with less effort (Abdulrahaman et al., 2020), capturing students' attention by providing mental stimuli through graphics and audio effects (Elsherbeni et al., 1995), stimulating students' enthusiasm, guiding learners to study actively by constructing the knowledge system on their own while learning, providing teachers with the ability to ascertain students' learning positions before implementing individualised teaching, improving teaching efficiency, and finally promoting the effective occurrence of learning outcomes (Liu, 2006; Abdulrahaman et al., 2020; Ye et al., 2021). Multimedia technology also promotes teachers' teaching effectiveness (Aquino & Chavez, 2022).

Although many researchers have carried out strategic studies on how to use multimedia effectively to promote teaching (Yang, 2021; Leng, 2018; Zhang et al., 2021), the effectiveness of multimedia teaching is still questioned. And there are also some problems in the use of multimedia technology, teaching methods, and educational concepts (Xie, 2019). On the other hand, previous studies were most often conducted in universities or collages and showed that multimedia technology guarantees a productive, interesting, interactive, motivating, and quality delivery of the instruction while addressing the needs of students (Keengwe, Onchwari, & Wachira, 2008a) in many different fields of education, like engineering laboratories (Abdulrahaman et al., 2020), art education (Ye et al., 2021), musical education (Niu, 2021; Zhang & Li, 2021; Li, 2021), physical education (Yan, 2021; Ren & Cui, 2020), and English teaching (Zhao et al., 2019; Zhang et al., 2021). By comparison, fewer studies have been conducted in primary schools as well as in Chinese classroom teaching.

Meanwhile, deep learning, a hot topic in the education field, is recognised internationally as the key to capability development in the 21st century. The American National Research Council's report Education for Life and Work (Pellegrino & Hilton, 2012), the National Curriculum in Norway (The Norwegian Directorate for Education and Training, 2020), and Chinese famous educators have stressed the key term "deep learning." Compared to surface learning, deep learning is more purposeful, meaningful, and active (Winje & Løndal, 2020), and it integrates what has been learned in a specific situation before transferring it to a new situation (Nehring & Szczesiul, 2015, p. 332). It is a deep-level learning method that aims to improve students' advanced thinking ability to solve practical and complex problems (Katona, 1940; He & Li, 2005) and has modern and contemporary significance and characteristics. Deep learning is necessary to help students cultivate subject-specific competence, metacognition, and self-regulated learning; to communicate, cooperate, and participate; to explore and create (NOU, 2015:8, pp. 8–10; Bråten & Skeie, 2020); and to promote the all-round development of students (Lin, 2016). This article adopts the National Research Council's (2012) point of view, which divides deep learning into three domains: cognitive, interpersonal, and intrapersonal. The cognitive domain involves reasoning and memory, which include the competencies of cognitive processes and strategies; academic knowledge; creativity; and critical thinking. The interpersonal domain refers to the ability to express ideas and interpret and respond to messages from others, which involves skills in communication, collaboration, responsibility, and conflict resolution. The intrapersonal domain involves the capacity to manage one's behaviour and emotions to achieve one's goals.

The majority of overseas empirical research on deep learning in the past ten years has focused on higher education and college students and has emphasised the social and natural sciences fields (Shen et al., 2019; Azizan et al., 2018). Moreover, the proportion of research on primary school students in China is only 3.52%, which is notably low and causes widespread concern (Shen et al., 2019). As for Chinese literacy instruction and learning, there is even less relevant research.

Moreover, with regard to the investigation on multimedia technology, deep learning, or both, the focus on teaching Chinese characters in primary school education is noticeably insufficient (Shen et al., 2019), so more relevant research is carried out based on a genuine analysis of the advantages and disadvantages of multimedia technology to explore strategies that promote students' literacy (Guo, 2019; Du, 2021) by obtaining relevant data through questionnaires on students and teachers (He, 2018; Xia, 2017). The instrument used for examining the effects of multimedia technology on deep learning is single in each study,

either a single test instrument (Amy Kuo et al., 2014) or a single questionnaire instrument (He, 2018; Xia, 2017).

To sum up, the lack of empirical research, the single instrument used in the relative study, and the few studies on formulating special and efficient multimedia technology-assisted literacy teaching are the research gaps in such a study. Thus, the purpose of this study is to investigate the effect of multimedia technology on the deep learning of Chinese characters for first-grade primary school students. Specifically, the objectives of this study are: (1) Is there any statistically significant difference in scores on the literacy achievement test between students taught with multimedia technology as compared to those taught with the traditional method? (2) Does the application of multimedia technology promote students' deep learning?

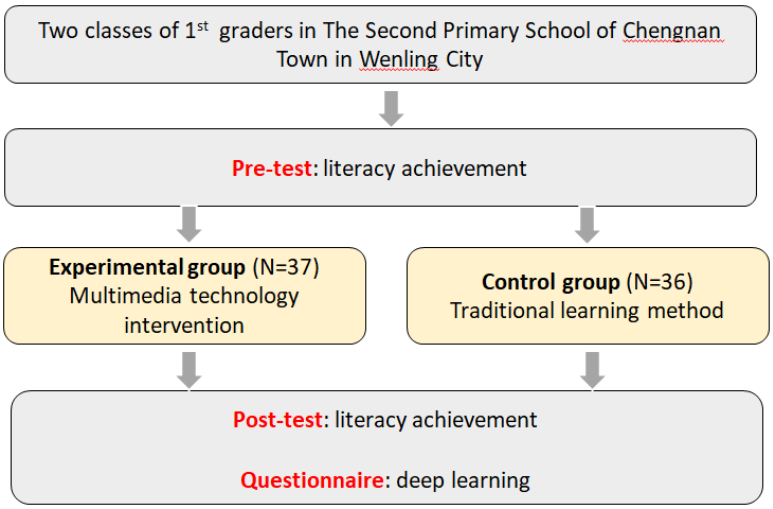
RESEARCH METHODOLOGY

A quasi-experimental design was used for this study's research design. The population in this study was 103 first-grade students from a primary school located in Wenling City, China. Meanwhile, the sample of 73 students in the study consists of those selected from two classes: the experimental class (n = 37) and the control class (n = 36). The sample was selected with the agreement of the school administrator. The random sampling method was adopted, which is a kind of probability sampling. Two classes with similar teaching levels and similar students' learning conditions were selected, and after the pre-test, these two classes were seen as the experimental class and the control class for the experiment.

One of the instruments in this study is a pre-post-test with five items to examine students' literacy achievement, which would be given to students before and after the instruction. Another one is a five-point Likert scale questionnaire that the National Research Council of the United States (2012) developed using three domains, namely cognition, intrapersonal, and interpersonal. The validity and reliability of these instruments were ensured by a small-scale pilot study (the Cronbach's alpha coefficient of the questionnaire is 0.956 and the Pearson correlation coefficient of the test-retest is 0.882 ($p = 0.001; < 0.05$) and experts' agreements.

Data was collected at the beginning and end of the 3-week experiment. At the beginning of the Chinese characters course, a pre-test was given to both the experimental group and the control group to test students' literacy achievement before learning. After conducting the instructions for the experimental group using multimedia technology intervention and for the control group using traditional learning methods, a post-test was implemented to examine whether students' literacy achievement improved, while a questionnaire was administered to explore whether their learning had reached depth. The researcher was not involved in the implementation of instruction in these two classrooms. The following Figure 1 shows the procedure for data collection in this quasi-experiment.

FIGURE 1
THE QUASI-EXPERIMENT'S DATA COLLECTION PROCEDURE



FINDINGS

Difference in Student Chinese Literacy Achievement

The Shapiro-Wilk normality test was initially conducted on the complete sample to assess normality, as shown in Table 1. The study utilised a paired t-test, a type of parametric test, to investigate the impact of treatment instructions and traditional methods. The decision to use this test was based on the normal distribution of the pre-test and post-test results with a p-value greater than 0.05.

TABLE 1
NORMALITY TEST ON PRE- AND POST-TESTS OF THE EXPERIMENTAL AND CONTROL GROUPS

		Statistics	df	Sig.
Experimental Group	Pre-test	.946	37	.074
	Post-test	.954	37	.127
Control Group	Pre-test	.974	36	.535
	Post-test	.961	36	.223

As shown in Table 2, there is a statistically significant difference between the pre-test and the post-test after using the multimedia technology to improve students' Chinese literacy ($t = -11.779$, $p = 0.000 < 0.05$), which implies the teaching using multimedia technology was successful and effective. While referring to the control group, there is a statistically significant difference between the pre-test and the post-test after teaching using the traditional method ($t = -12.706$, $p = 0.000 < 0.05$), meaning that the teaching conducted traditionally was successful.

TABLE 2
PAIRED SAMPLES T-TEST OF THE EXPERIMENTAL AND CONTROL GROUPS

		N	Mean	Std. Deviation	t	Sig. (2-tailed)
Pair Experimental group	Pre-test Post-test	37	-21.00000	10.84487	-11.779	.000
Pair Control Group	Pre-test Post-test	36	-17.36111	8.19809	-12.706	.000

To address the research question and investigate potential disparities between the experimental group using multimedia technology and the control group using traditional teaching approaches, an initial normality test was conducted on the complete sample of both groups using the Shapiro-Wilk normality test. Table 3 displays that the data distribution of the post-test results for both the experimental and control groups is normal. The p-values for the experimental group and control group are 0.127 and 0.223, respectively, both of which are greater than the significance level of 0.05. Following this, it is possible to employ an independent t-test and a parametric test to ascertain whether there exists a statistically significant disparity in the scores obtained on the Chinese literacy achievement test by two distinct groups.

TABLE 3
NORMALITY TEST ON THE POST-TESTS OF TWO INDEPENDENT GROUPS

		Statistics	df	Sig.
Post-test	Experimental Group	.954	37	.127
	Control Group	.961	36	.223

Table 4 presents the mean and standard deviation values for two groups of students, one taught using multimedia technology and the other using the conventional method. The mean score for the multimedia group is 75.59 with a standard deviation of 12.99, while the mean score for the conventional group is 71.14 with a standard deviation of 15.20. The p value of 0.182 indicates that the statistical significance level exceeds the predetermined threshold of 0.05. Therefore, the null hypothesis cannot be rejected. The results suggest that there is no statistically significant difference in the Chinese literacy scores of students instructed through the multimedia technology approach in comparison to those instructed through the conventional method. While it is true that students instructed through multimedia technology tend to exhibit greater academic performance than those instructed through traditional means, this does not necessarily imply that the multimedia technology method is superior to the traditional method. The observed phenomenon could potentially be attributed to the relatively effective instructional design employed by both groups, which has resulted in significant advancements in the Chinese literacy skills of the students in each group.

TABLE 4
INDEPENDENT SAMPLES TEST

Group	N	Mean	Std. Deviation	F	df	t	Sig. (2-tailed)
Experimental Group	37	75.5946	12.98816	.304	71	1.348	.182
Control Group	36	71.1389	15.19991				

Difference in Deep Learning of Chinese Characters Between Groups

To answer the question whether the multimedia technology promotes the deep learning of primary school students on their Chinese literacy achievement, the questionnaire was analysed by calculating the

average of each domain for each group and using the related inferential statistics, such as the normality test, independent t-test, and Mann-Whitney U test.

The Mann-Whitney U test was employed to analyse the data pertaining to the cognitive and intrapersonal domains of deep learning. This was due to the non-normal distribution of the data, as indicated by the p-values of 0.012 and 0.027, respectively, both of which were below the significance level of 0.05. Table 5 displays the usage of an independent t-test in the interpersonal domain due to the observed p value of 0.101 ($p > 0.05$).

TABLE 5
NORMALITY TEST ON EACH DOMAIN OF DEEP LEARNING

	Statistic	df	Sig.
Cognitive Domain	.956	73	.012
Interpersonal Domain	.972	73	.101
Intrapersonal Domain	.962	73	.027

Table 6 displays the average rank of the cognitive domain for both the experimental and control groups, with the former having a mean rank value of 39.47 and the latter having a mean rank value of 34.46. The experimental group exhibits a mean rank of 40.55 in the intrapersonal domain, whereas the control group displays a mean rank of 33.35 in the same domain. The results suggest that the null hypothesis should be upheld, as the p-values for the cognitive and intrapersonal domains in the experimental and control groups of the study are 0.311 and 0.146, respectively, indicating no statistically significant difference between the two groups ($p > 0.05$). According to the National Research Council (2012), there were no notable variances observed between the two groups in terms of their cognitive processes and strategies, academic knowledge, creativity, and critical thinking (cognitive domain), or their abilities to engage in positive core self-evaluation and metacognition to assess their own learning and adapt accordingly (intrapersonal domain).

TABLE 6
MANN-WHITNEY U TEST ON THE COGNITIVE AND INTRAPERSONAL DOMAINS OF DEEP LEARNING

	Group	N	Mean Rank	Z	Asymp. Sig. (2-tailed)
Cognitive Domain	Experimental group	37	39.47	-1.014	.311
	Control group	36	34.46		
Intrapersonal Domain	Experimental group	37	40.55	-1.455	.146
	Control group	36	33.35		

The findings presented in Table 7 demonstrate that the cohort instructed through multimedia technology exhibited a mean score of 4.08 with a standard deviation of 0.515. In contrast, the group taught through traditional methods had a mean score of 3.74 with a standard deviation of 0.457. The obtained p-value of 0.004, which is less than the predetermined significance level of 0.05, led to the rejection of the null hypothesis. The use of multimedia technology in teaching has been found to result in a statistically significant difference in the interpersonal domain of deep learning when compared to the traditional method of teaching among students. The aforementioned statement suggests that the use of multimedia technology as a pedagogical tool for instructing Chinese characters has the potential to facilitate students' profound comprehension in the interpersonal domain. This domain encompasses various competencies such as communication, collaboration, responsibility, and conflict resolution, as defined by the National Research Council in 2012.

TABLE 7
INDEPENDENT T-TEST ON THE INTERPERSONAL DOMAIN OF DEEP LEARNING

	Group	N	Mean	Std. Deviation	F	df	t	Sig. (2-tailed)
Interpersonal Domain	Experimental group	37	4.0811	.51457	.422	71	2.974	.004
	Control group	36	3.7421	.45666				

DISCUSSION

Differences in Students' Literacy Achievement Improvement

The findings presented in Chapter 4 of this study indicate a statistically significant difference in the literacy achievement of students before and after being taught using multimedia technology. The mean score of literacy achievement in the experimental group was observed to be higher than that of the control group. The improvement observed in the students' literacy achievement is consistent with the findings of Sun's (2019) prior study, which demonstrated that the comprehensive use of modern multimedia technology enhances the literacy skills of first-year students. According to the studies by Chen (2019) and Xie (2019), multimedia technology is a contributing factor in the enrichment of classroom instruction content and the improvement of classroom teaching quality and efficiency. According to Mayer's research conducted in 1989, the incorporation of multimedia technology into learning materials, such as text and images, has the potential to improve students' learning outcomes.

The study found no statistically significant variance in the Chinese literacy scores between students instructed by the multimedia technology approach and those taught using traditional methods. Nonetheless, the experimental group's average score on the post-test was higher than that of the control group. The relatively effective instructional design that both groups used may be to blame for the lack of a noticeable difference in the literacy achievement of the two groups. Students in both groups made significant improvements on the post-test, demonstrating that this led to noteworthy advancements in the Chinese literacy class. However, there exist certain challenges pertaining to the use of multimedia in educational settings. For instance, the over-reliance on multimedia instruction may divert students' attention towards the novelty of visual and audio aids, thereby impeding their ability to concentrate on the subject matter and ultimately impacting their learning outcomes (Wang & Yue, 2017).

Differences in Students' Deep Learning

Additionally, the present study also indicated that the use of multimedia technology is more effective in enhancing students' interpersonal ability, which is one of the domains of deep learning. The null hypothesis referring to the interpersonal domain of deep learning in this study is rejected, and the alternative hypothesis is accepted as there is statistically significant value for using multimedia technology to cultivate students' interpersonal ability, like teamwork skills, which is consistent with Azizan et al. (2018), whose study was about improving teamwork skills and enhancing deep learning via games, which is also part of the Chinese character instruction in this study. The results may also be attributed to the fact that the cognitive load of the learner will be reduced when the interpretation of sounds and images replaces the combination of visual texts and images (Wang & Wei, 2018), so that students are more relaxed and willing to interact with peers and teachers.

However, the results show that there is no statistically significant difference in the cognitive domain and the intrapersonal domain between the experimental group and the control group in the study. The main reasons are: (1) in order to exclude the influence of other variables, the teaching objectives of the two classes designed in this study are basically the same, so there is no significant difference in cognitive condition on the knowledge between the two classes; and (2) the situations of students‘ self-relationship

(an intra-personal skill) are also similar because the two classes have the same teaching staff, so the methods of developing their learning habits and self-reflection skills are the same.

CONCLUSION AND FUTURE RESEARCH

The study's results indicate that multimedia technology has a positive impact on promoting students' Chinese literacy achievement. The multimedia approach offers students a comprehensive learning experience by incorporating visual and auditory elements alongside textual and graphical information. This method facilitates the transformation of abstract concepts into tangible ones, enables the presentation of vast amounts of information within a restricted timeframe with minimal exertion, and fosters students' engagement in the learning process. Educators are encouraged to utilise multimedia technology to enhance students' communication, collaboration, responsibility, and conflict resolution skills.

The researcher believes that additional research is necessary to provide more reliable research findings in an endeavour to use multimedia technology in students' classroom instruction of Chinese characters. First, a larger population should be included in the study's scope so that the results can encompass a larger population. Second, to have a more significant impact on the research, the length of the deep learning activities using multimedia technology could be increased to eight weeks or longer. Third, future studies must take into account a few potential variables, such as the expectation effect of teachers and the lesson plan, the preference effect of teachers for traditional and experimental activities, etc. Last but not least, developing the modules connected to multimedia technology and deep learning instruction is also necessary research for the future. This will encourage curriculum designers and educational policymakers to create more pertinent, helpful, and successful judgements and teaching strategies.

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